Study of Demolding Characteristics in Continuous UV Nanoimprinting

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In nanoimprint lithography that requires defect free processes on the occasion of the industrialization, the biggest challenge lies at the separation of the mold from the imprinted resist. Although the treatment of mold surface with an anti-sticking agent promises easy demolding, the durability of the layer against multiples of UV nanoimprint remains in critical problem. With the test machine of which the automatic UV nanoimprinting operation is capable, continuous imprints were conducted with 6x6mm quarts mold (Figure1) in 6.5mm pitch on a 6 inch wafer (Figure2). Demolding forces in each shot of imprinting were recorded and water contact angles of the mold surface were determined in every 225 shots of imprint to see the degree of anti-sticking layer degradation in terms of water contact angle as the imprints proceed. The mold was treated with anti-sticking agent. PAK-02 and C-TGC-02 (TOYOGOSEI) were used as a UV curable resist. PFP (pentafluoropropane) gas was used for the imprinting environment and compared with the air, as PFP is known to have the reducing effect of the demolding forces[1]. This work revealed that the average demolding force in PFP dropped to 0.12N from 2.5N of that in the air as is shown in Figure 1 and 2. In figure 5 with PAK-02 the water contact angle dropped to 54 degree after 625 steps in the air and imprint defects appeared at around 350th step, while in PFP the contact angle slowly reduced to 72 degree after 1800 steps and imprint defects appeared at around 1350th step. With C-TGC-02 in PFP the contact angle held up 90 degree after 1800 steps, and thereafter showed steep drop to around 80 degree along with continuous large defects with another 225 steps, but from the analysis of the defects the drop of the contact angle was thought to have depended not on the degradation of the anti-sticking layer but rather on the defects generated by the scar on the mold surface. What was found is that PFP is effective to elongate the mold life and that the right selection of UV curable resist holds the key for the mass production with UV nanoimprinting technology.

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[1] H. Hiroshima: J. Vac. Sci. Technol. B **27** 2862 (2009)

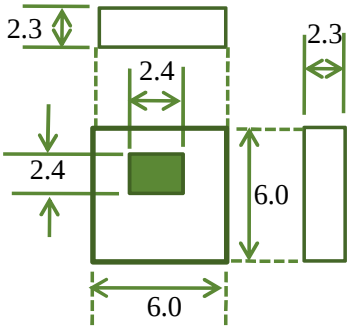

Figure 1 Schematic image of quarts mold

- Pattern: 200nm line & space
- Depth: 300nm

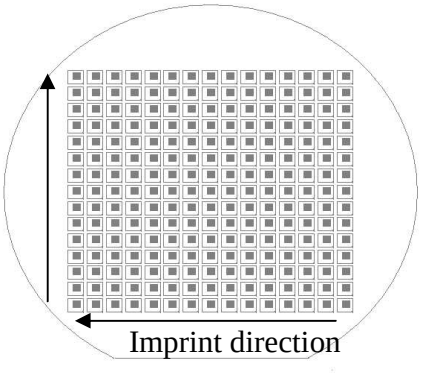

Figure 2 UV nanoimprint configurations on a 6 inch wafer

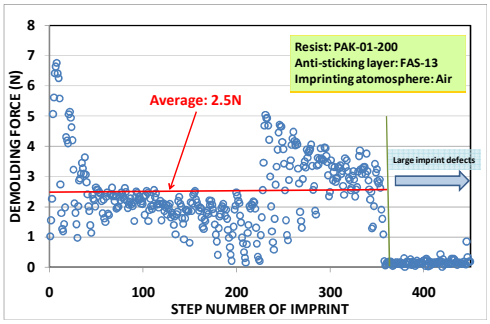

Figure 3 Demolding force plotted against step number of imprint in the air

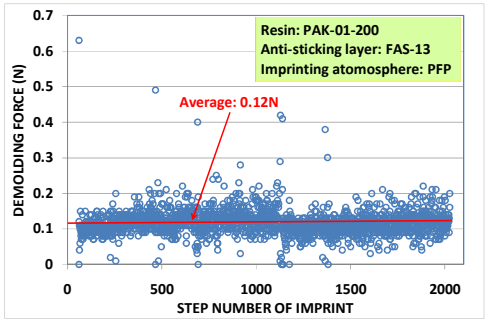

Figure 4 Demolding force plotted against step number of imprint in the PFP gas environment

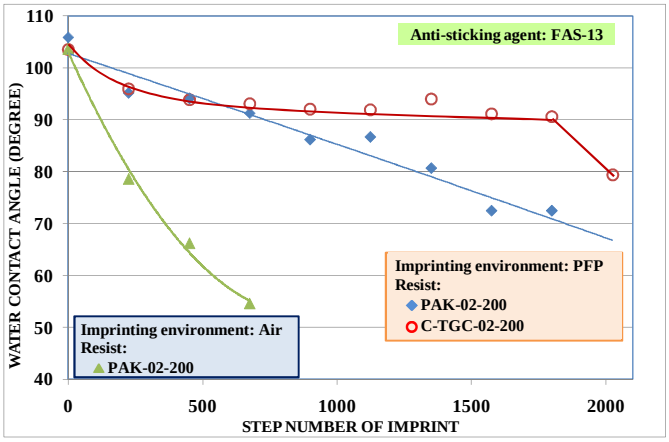

Figure 5 Water contact angle plotted against step number of imprint in every 225 step

▲ PAK-02 in the air ◆ PAK-02 in PFP ○ C-TGC-02 in PFP